DOCUMENT RESUME

ED 448 355 CE 081 166

TITLE	Illinois Occupational Skill Standards: Mechanical Drafting Cluster.
INSTITUTION	Illinois Occupational Skill Standards and Credentialing Council, Carbondale.
SPONS AGENCY	Illinois State Board of Education, Springfield.
PUB DATE	2000-08-00
NOTE	99p.; For other skill standards, see CE 080 474-492 and CE 081 161-167.
AVAILABLE FROM	Curriculum Publications Clearinghouse, Western Illinois University, Horrabin Hall 46, 1 University Circle, Macomb, IL 61455-1390. Tel: 800-322-3905 (Toll Free); Fax: 309-298-2869; e-mail: CPC@wiu.edu; Web site: http://www.standards.siu.edu. For full text: http://www.standards.siu.edu/pdf/transportation/Mechanic.pdf.
PUB TYPE	Guides - Non-Classroom (055) -- Legal/Legislative/Regulatory Materials (090)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Academic Standards; Advisory Committees; Behavioral Objectives; Blueprints; Competence; Competency Based Education; Computer Assisted Design; Data Analysis; Definitions; Diagrams; Drafting; Education Work Relationship; Educational Benefits; Educational Needs; Educational Objectives; Employment Potential; Employment Qualifications; *Engineering Drawing; Equipment Utilization; Evaluation Criteria; Geometric Concepts; Geometric Constructions; Glossaries; Guidelines; Information Retrieval; Job Performance; Job Skills; Job Training; Labor Force Development; Models; Occupational Clusters; Orthographic Projection; *Performance Based Assessment; Postsecondary Education; Program Guides; Secondary Education; *State Standards; Statewide Planning; Student Certification; *Student Evaluation; *Technical Education; Technical Illustration
IDENTIFIERS	*Illinois

ABSTRACT

This document, which is intended as a guide for work force preparation program providers, details the Illinois occupational skill standards for programs preparing students for employment in occupations in the mechanical drafting cluster. The document begins with a brief overview of the Illinois perspective on occupational skill standards and credentialing, the process used to develop the skill standards, and assumptions underlying the standards. Presented next are skill standards for 23 tasks typically performed by workers involved in mechanical drafting. Each skill standard statement contains the following components: (1) the actual skill standard (including the conditions of performance, work to be performed, and performance criteria); (2) performance elements and assessment criteria; and (3) a recommended assessment and credentialing approach. The following are among the tasks for which skill standards are provided: measure using scales; draw geometric constructions; reference information from available sources; create a computer-aided drafting (CAD) model; and analyze CAD models. The

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following items are appended: glossary; list of Illinois Occupational Skill Standards and Credentialing Council members; list of Transportation, Distribution, and Logistics Subcouncil members; list of Mechanical Drafting Cluster Standards Development Committee members; Transportation, Distribution, and Logistics Subcouncil Mechanical Drafting Cluster skill standards recognition proposal; and list of necessary workplace skills. (MN)

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ED 448 355

ILLINOIS

OCCUPATIONAL SKILL STANDARDS

MECHANICAL DRAFTING CLUSTER

CE081166

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MECHANICAL DRAFTING CLUSTER

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ILLINOIS OCCUPATIONAL SKILL STANDARDS

MECHANICAL DRAFTING CLUSTER

Endorsed for Illinois
by the
Illinois Occupational Skill Standards and
Credentialing Council

MESSAGE TO ILLINOIS CITIZENS

Dear Citizens of Illinois:

Preparing youth and adults to enter the workforce and to be able to contribute to society throughout their lives is critical to the economy of Illinois. Public and private interest in establishing national and state systems of industry-driven skill standards and credentials is growing in the United States, especially for occupations that require less than a four-year college degree. This interest stems from the understanding that the United States will increasingly compete internationally and the need to increase the skills and productivity of the front-line workforce. The major purpose of skill standards is to promote education and training investment and ensure that this education and training enables students and workers to meet industry standards that are benchmarked to our major international competitors.

The Illinois Occupational Skill Standards and Credentialing Council (IOSSCC) has been working with industry subcouncils, the Illinois State Board of Education and other partnering agencies to adopt, adapt and/or develop skill standards for high-demand occupations. Skill standards products are being developed for a myriad of industries, occupational clusters and occupations. This document represents the collaborative effort of the Transportation, Distribution and Logistics Subcouncil, Communications/Information Technology Subcouncil, and the Mechanical Drafting Cluster Standards Development Committee.

These skill standards will serve as a guide to workforce preparation program providers in defining content for their programs and to employers to establish the skills and standards necessary for job acquisition. These standards will also serve as a mechanism for communication among education, business, industry and labor.

We encourage you to review these standards and share your comments. This effort has involved a great many people from business, industry and labor. Comments regarding their usefulness in curriculum and assessment design, as well as your needs for in-service and technical assistance in their implementation are critical to our efforts to move forward and improve the documents.

Questions concerning this document may be directed to:

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We look forward to your comments.

Sincerely,

The Members of the IOSSCC

THE ILLINOIS PERSPECTIVE

The Illinois Occupational Skill Standards and Credentialing Council (IOSSCC) endorses occupational skill standards and credentialing systems for occupations that (a) require basic workplace skills and technical training, (b) provide a large number of jobs with either moderate or high earnings, and (c) provide career advancement opportunities to related occupations with moderate or high earnings. The nine-member Council was established by the Occupational Skill Standards Act (PA 87-1210). The Council, representing business, industry and labor and working with the Illinois State Board of Education in partnership with the Illinois Community College Board, Illinois Board of Higher Education, Illinois Department of Employment Security and Illinois Department of Commerce and Community Affairs, has created a common vision for workforce development in Illinois.

Vision

It is the vision of the IOSSCC to develop a statewide system of industry-defined and recognized skill standards and credentials for all major skilled occupations providing strong employment and earnings opportunities in Illinois. Information related to occupational employment and earning opportunities is determined by the Illinois Occupational Information Coordinating Committee (IOICC) in cooperation with business and industry.

Subcouncils and Standards Development Committees

Under the direction of the Council, and in cooperation with organizations such as the Illinois Chamber of Commerce, the Illinois AFL-CIO, the Illinois Manufacturers' Association, and others, Industry Subcouncils have been formed to review, approve and promote occupational skill standards and credentialing systems. The Industry Subcouncils are Agriculture and Natural Resources; Applied Science and Engineering*; Business and Administrative Information Services; Communications/Information Technology; Construction*; Education and Training Services*; Energy and Utilities*; Financial Services; Health and Social Services; Hospitality; Legal and Protective Services*; Manufacturing; Marketing and Retail Trade; and Transportation, Distribution and Logistics. (*Subcouncils currently being formed.)

The Standards Development Committees, composed of business, labor and education representatives, are experts in the related occupational cluster and work with the product developer to

- develop or validate occupational skill standards,
- identify related academic skills,
- develop or review assessment or credentialing approaches, and
- recommend endorsement of the standards and credentialing system to the industry subcouncil.

Expected Benefits for Employers, Educators, Students and Workers

Occupational skill standards and credentialing systems are being developed and promoted by the IOSSCC to improve Illinois' competitiveness. Such standards and credentialing systems provide a common language for employers, workers, students and education and training providers to communicate skill requirements and quality expectations for all major industry and occupational areas.

For Employers, skill standards will

- Improve employee recruitment and retention by more clearly identifying skill requirements,
- Encourage improved responsiveness and performance of education and training providers,
- Enlarge the pool of skilled workers,
- Focus attention on the importance of training investment.

For Education and Training Providers, skill standards will

- Provide information on all major industries and occupations,
- Contribute to program and curriculum development,
- Strengthen relationships between educators and training providers,
- Improve career planning.

For Students and Workers, skill standards will

- Foster better decision making concerning careers and the training necessary to acquire well-paying jobs,
- Allow more effective communication with employers about what they know and can do,
- Allow more effective work with employers in career development and skill upgrading.

IOSSCC Requirements for Occupational Skill Standards

Any occupational skill standards and credentialing system seeking IOSSCC endorsement must

- represent an occupation or occupational cluster that meets the criteria for IOSSCC endorsement;
- address both content and performance standards for critical work functions and activities for an occupation or occupational area;
- ensure formal validation and endorsement by a representative group of employers and workers within an industry;
- provide for review, modification and revalidation by an industry group a minimum of once every five years;
- award credentials based on assessment approaches that are supported and endorsed by the industry and consistent with nationally recognized guidelines for validity and reliability;
- provide widespread access and information to the general public in Illinois;
- include marketing and promotion by the industry in cooperation with the partner state agencies.

Definitions and Endorsement Criteria

The definitions and endorsement criteria are designed to promote the integration of existing and future industry-recognized standards, as well as the integration of the Illinois academic and occupational skill standards. Because all skill standards must address the critical work functions and activities for an occupation or industry/occupational area, the Council further defined three major components:

- ***Conditions of Performance:*** The information, tools, equipment and other resources provided to a person for a work performance.
- ***Statement of Work:*** A description of the work to be performed by a person.
- ***Performance Criteria:*** The criteria used to determine the required level of performance. These criteria could include product characteristics (e.g., accuracy levels, appearance), process or procedural requirements (e.g., safety, standard professional procedures) and time and resource requirements.

The IOSSCC is currently working with the Illinois State Board of Education and other state agencies to integrate the occupational standards with the Illinois Learning Standards which describe what students should know and be able to do as a result of their education. The Council is also working to integrate workplace skills—problem solving, critical thinking, teamwork, etc.—with both the Learning Standards and the Occupational Skill Standards.

The Illinois Model

Illinois Occupational Skill Standards describe what people should know and be able to do and how well these skills and knowledge will be demonstrated in an occupational setting. They focus on the most critical work performances for an occupation or occupational area. As seen in the following model, Illinois Occupational Skill Standards contain at least these areas:

- Performance Area
- Performance Skill
- Skill Standard
- Performance Elements
- Performance Assessment Criteria

Illinois Occupational Skill Standards also carry a coding at the top of each page identifying the state, fiscal year in which standards were endorsed, subcouncil abbreviation, cluster abbreviation and standard number. For example, the twenty-fifth skill standard in the Mechanical Drafting Cluster, which has been developed by the Transportation, Distribution and Logistics would carry the following coding: IL.00.TRANS.MDC.25.

A model for Illinois Occupational Skill Standards showing the placement of the coding and providing a description of each area within a standard is contained on the following page.

SUMMARY OF WORK TO BE PERFORMED. SUMMARY IS BRIEF AND BEGINS WITH AN ACTION VERB.

IL.FY.SUBCOUNCIL. CLUSTER. STANDARD NO.

PERFORMANCE AREA

SKILL STANDARD

CONDITIONS OF PERFORMANCE

A comprehensive listing of the information, tools, equipment and other resources provided to the person(s) performing the work.

WORK TO BE PERFORMED

An overview of the work to be performed in demonstrating the performance skill standard. This overview should address the major components of the performance. The detailed elements or steps of the performance are listed under "Performance Elements."

PERFORMANCE CRITERIA

The assessment criteria used to evaluate whether the performance meets the standard. Performance criteria specify product/outcome characteristics (e.g., accuracy levels, appearance, results, etc.) and process or procedure requirements (e.g., safety requirements, time requirements, etc.).

PERFORMANCE ELEMENTS

Description of the major elements or steps of the overall performance and any special assessment criteria associated with each element.

PERFORMANCE ASSESSMENT CRITERIA

Listing of required testing, certification and/or licensing.

Product and process used to evaluate the performance of the standard.

PRODUCT

Description of the product resulting from the performance of the skill standard.

PROCESS

Listing of steps from the Performance Elements which must be performed or the required order or performance for meeting the standard.

DEVELOPMENTAL PROCESS

After reviewing current labor market information, the Illinois Occupational Skill Standards and Credentialing Council's (IOSSCC's) Standards Development Committee's subcouncil recommended the development of skill standards for mechanical drafters. The identified career, Mechanical Drafter, meets the criteria established by the IOSSCC for performance skill standard development, education and training requirements, employment opportunities, earnings potential and career opportunities. A product developer knowledgeable of mechanical drafting began the process of performance skill identification. The product developer prepared an outline and framework based on the national drafting skills which address the major skills expected in the workplace. The framework addresses skill requirements common to the mechanical industry.

Job descriptions which describe the field of mechanical drafting and the necessary competencies required, as reflected in related educational programs, texts, and national standards, were solicited and received. Common and accepted references provided reinforcement for the direction given in the framework.

A Standards Development Committee composed of professionals from the mechanical drafting field was convened. The framework, initial outline, matrix and drafting skill standards were presented to the Standards Development Committee for review, revision, adjustment and validation. Additional skill standards statements with performance elements and assessment criteria were developed in accordance with the direction established by the IOSSCC and presented to the Standards Development Committee for review and revision. Educators joined the Standards Development Committee at a final meeting to review consistency in terminology and the assessment criteria used. The performance assessment criteria include a product statement that indicates the outcome or end result of performing the skill, as well as a process statement to identify the steps of performance critical to the outcome and/or a specific sequence to be followed. The Standards Development Committee provided drafting examples as a basis for establishing a timeframe for completing the skill and determining the level of difficulty individuals entering the workforce are expected to achieve. The examples are original in nature and were not intended to duplicate existing material. Any similarities to existing drawings or literature are coincidental.

Performance elements and assessment criteria were developed using standard references. The initial and concluding parts of the format establish a standard of personal commitment and serve as a reminder of expected workplace behaviors. The central section varies in length and outlines the specific criteria expected for evaluation in the learning environment and for entry into the workplace. The criteria are behavioral statements of skill standards and, as such, serve as an evaluation tool and workplace guide rather than as a prescription for curriculum.

A complete set of skill standards was provided to the Transportation, Distribution and Logistics Subcouncil. The Subcouncil approved and recommended the standards be endorsed by the IOSSCC. A statement of assumptions accompanies this document to provide context for the standards document.

ASSUMPTIONS FOR MECHANICAL DRAFTING CLUSTER STANDARDS

Skill standards statements assume:

1. Workplace skills (employability skills) are expected of all individuals. Socialization skills needed for work are related to lifelong career experience and are not solely a part of the initial schooling process. A listing of these skills is not included with this set of statements.
2. Specific policies and procedures of the work site will be made known to the individual and will be followed.
3. Time elements outlined for the skill standards result from the experience and consideration of the panel of experts who made up the Standards Development Committee.
4. Skills will progress from simple to complex. Once a skill has been successfully performed, it will be incorporated into more complex skills.
5. Skill standards describe the skill only and do not detail the background knowledge or theory related to the particular skill base. Although the skill standard enumerates steps to successful demonstration, rote approaches to the outcomes are not prescribed.
6. All work is expected to be completed in an expedient manner.
7. Skill standards are selected because they meet workplace needs and are designed to meet professional standards of practice.
8. Skill standards in no way supersede or take the place of certification or graduation from accredited programs of study.
9. Drafting equipment and tools are maintained and kept clean.
10. Skills are identifiable, measurable standards of practice which practitioners may use to demonstrate competency to employers. Practitioners and graduates may develop portfolios of competencies to accompany them into a competitive workplace.
11. Skill standards are written to show what the drafter is required to do in order to demonstrate competency.
12. Skill standard completion time is based on hand or CAD skill performance. The Standards Development Committee emphasizes that the time indicator may be the same whether the drafter completes the skill by hand or by CAD. Technological advances in CAD can reduce the amount of time necessary for creating and/or modifying existing CAD drawings. CAD also has the capability of producing neater, more accurate drawings and designs than does drafting by hand.
13. Drafters are able to create freehand sketches and transfer information from sketches to a drawing.
14. Drafters are able to operate hardware by (1) operating and adjusting input devices (e.g., mouse, keyboard, digitizer), (2) operating and adjusting output devices (e.g., printers, plotters), (3) correctly operating and handling storage media, (4) starting and shutting down a work station, (5) adjusting a monitor control for maximum comfort and usability, and (6) recognizing the availability of information services (e.g., electronic mail, bulletin boards).
15. Drafters are able to operate the system by (1) starting and exiting a software program as required, (2) identifying, creating and using a directory structure and changing directory paths, (3) demonstrating proper file maintenance and backup procedures, (4) translating, importing, and exporting data files between formats (e.g., IGES), (5) using on-line help, (6) saving drawings to storage devices, and (7) minimizing file size.
16. A company will have a standard title block for its facility. The Standard Development Committee stresses that it is important for all individuals to know the importance and application of a title block. It is not necessary to develop a title block, but important to be able to complete one.
17. When unfamiliar with symbols used in various areas of drafting, drafters are able to locate necessary information from reference sources.

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PERFORMANCE SKILL LEVELS

	DRAFTS PERSON DETAILER	CHECKER*
BASIC DRAFTING		
Identify and Apply the "Alphabet of Lines"	•	•
Measure Using Scales	•	•
Construct Proper Lettering	•	•
Draw Geometric Constructions	•	•
Construct a Multiview (Orthographic 2-D) Drawing	•	•
Develop a Pictorial (3-D) Drawing	•	•
Reference Information from Available Sources	•	•
Dimension Drawings	•	•
Apply Notes and Leaders	•	•
Make Drawing Revisions	•	•
MECHANICAL DRAFTING		
Prepare Isometric Drawing	•	•
Draw Section Views	•	•
Construct an Auxiliary View	•	•
Identify Threads and Thread Nomenclature	•	•
Draw and Label Fasteners	•	•
Construct an Assembly Drawing	•	•
Identify Gears and Gearing Nomenclature	•	•
Identify Cams, Cam Nomenclature and Sketch a Cam Profile	•	•
Identify Welding Joints, Nomenclature and Symbology	•	•
Identify Tolerancing Symbols and Feature Control Information	•	•
Identify surface Finish Symbology	•	•
MECHANICAL DRAFTING CAD SKILLS		
Create a CAD Model and Drawing	•	○
Analyze CAD Model	•	•

**Checkers are required to have on-the-job experience. They must know company standards, ANSI-ISO standards, geometric tolerancing, and manufacturing processes. They check to endure parts can be made and standard tooling can be used in addition to verifying that all dimensions necessary for manufacturing the part are present.*

IDENTIFY AND APPLY THE "ALPHABET OF LINES".

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drawing (Sample drawing in Attachment B)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Identify and apply the "Alphabet of Lines."

PERFORMANCE CRITERIA

All lines are distinct, easily read and of the appropriate line weight and type.

The skill is completed within a one-hour time period. (Time is based on using drawing in Attachment B to complete the skill.)

PERFORMANCE ELEMENTS

1. Identify "Alphabet of Lines" by name, line type variation, order of usage and application on technical drawings.
   a. Object line
   b. Hidden line
   c. Center line
   d. Section line
   e. Dimension line
   f. Extension line
   g. Cutting plane line
   h. Short break line
   i. Long break line
   j. Phantom line
2. Duplicate drawing using proper line thickness and the "Alphabet of Lines."
3. Darken finish lines.
4. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed drawing illustrates the "Alphabet of Lines" have been correctly applied.

PROCESS

All performance elements are critical for correctly applying the "Alphabet of Lines" on a drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill.

MEASURE USING SCALES.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drafting kit (Attachment A)
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Perform measurements using scales.

PERFORMANCE CRITERIA

The skill is completed within a one-hour time period.

PERFORMANCE ELEMENTS

1. Research types of measurement systems used in industry.
   a. Inch/foot system
   b. Metric (SI) system
2. Research different types of scales utilized and how they are used for measurements.
   a. Architectural
   b. Metric
   c. Engineering
   d. Civil
3. Research scaling and proportion.
   (e.g., 1:1, 100:1, ¼"=1'-0", ¾ size, 1:50, 1"=1000', etc.)
4. Draw horizontal line five inches in length and apply scaling techniques by measuring line to the following scales. (Print correct scaled length above each line.)
   a. Architectural scale (1:1, 1/8"=1'-0", ¼"=1'-0", 3/8"=1'-0", ½"=1'-0", ¾"=1'-0", 1"=1'-0", ½ size, 1-1/2 size, 1/48 size)
   b. Metric scale (1:2 ratio, 1:20, 1:200, 1:2000, 1:5, 1:33 1/3, 1:25, 1:75)
   c. Engineer scale (full size, ½ size, 1"=100")
   d. Civil scale (1"=5000', 1"=50', half size)
5. Check results.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Using scales to measure is correctly completed.

PROCESS

All performance elements are critical for correctly measuring using scales.

CONSTRUCT PROPER LETTERING.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Sample text (Attachment C)
Drafting kit (Attachment A)
Drawing paper with title block and border (8 ½ "x 11")
Drafting reference text

WORK TO BE PERFORMED

Construct proper lettering.

PERFORMANCE CRITERIA

All lines are distinct, easily read and of the appropriate line weight and type.

The skill is completed within a one-hour time period. (Time is based on using text in Attachment C to complete the skill.)

PERFORMANCE ELEMENTS

1. Use T-square, parallel bar, or lettering guide to draw two guidelines 1/8" apart horizontally across top of drawing paper.
2. Skip down 1/4" and draw another pair of guidelines 1/8" apart horizontally. Repeat line pairs across paper from top down to bottom.
3. Reproduce passage from text (letters and numbers), fill the drawing completely by printing 1/8" high vertical Gothic capital letters within guidelines.
4. Form each letter and number carefully and consistently.
5. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed drawing illustrates the lettering has been constructed properly.

PROCESS

All performance elements are critical for constructing lettering properly on a drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill.

DRAW GEOMETRIC CONSTRUCTIONS.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Draw geometric constructions.

PERFORMANCE CRITERIA

The completed drawing illustrates a series of geometric shapes and activities.

All lines are distinct, easily read and of the appropriate line weight and type.

The finished drawing is neat and clear of smudges and completed within a two-hour time period.

PERFORMANCE ELEMENTS

1. Draw geometric shapes without use of templates or CAD libraries.
   a. Circles
   b. Regular polygons with four, seven, and eight sides
   c. Pentagon inscribed within measured circle
   d. Hexagon circumscribed about measured circle
   e. Ellipse
   f. Parabola
   g. Triangles whose angles measure 30,60,90; 71,62,47; 20,80,80; 10, 58, 112
   h. Tangent lines tangent to two circles; tangent to two arcs
   i. Arcs thru three points; tangent to two circles
2. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed drawing correctly illustrates the required geometric shapes.

PROCESS

All performance elements are critical for producing a drawing illustrating a series of geometric shapes and activities.

CONSTRUCT A MULTIVIEW (ORTHOGRAPHIC 2-D) DRAWING.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drawing (Sample drawing in Attachment D)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Construct a multiview (orthographic 2-D) drawing.

PERFORMANCE CRITERIA

The drawing illustrates three views of an object with correct line representation.

All lines are distinct, easily read and of the appropriate line weight and type.

The finished drawing is neat and clear of smudges and completed within a half-hour time period. (Time is based on using drawing in Attachment D to complete the skill).

PERFORMANCE ELEMENTS

1. Select proper views.
2. Identify types of lines to be used.
3. Construct full scale (1:1) orthographic 3-view drawing using third angle projection with top, front, and right side views. Show all hidden features and centerlines.
4. Complete title block by selecting lettering style and size.
5. Apply proper thickness to all lines.
6. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The finished multiview (orthographic 2-D) drawing is constructed correctly.

PROCESS

All performance elements are critical for constructing a multiview (orthographic 2-D) drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill.

DEVELOP A PICTORIAL (3-D) DRAWING.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drawing (Sample drawing in Attachment E)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Develop a pictorial (3-D) drawing.

PERFORMANCE CRITERIA

The drawing has a correct view orientation.

All lines are distinct, easily read and of the appropriate line weight and type.

The finished drawing is neat and clear of smudges and completed within a one-hour time period. (Time is based on using drawing in Attachment E to complete the skill.)

PERFORMANCE ELEMENTS

1. Lay out isometric corner with left and right side lines each 30 degrees up from horizontal and third line at a vertical, with all three lines joining in a common intersection.
2. Use isometric corner to construct full scale (1:1) basic isometric drawing, including hidden features.
3. Complete title block by selecting lettering style and size.
4. Apply proper thickness to lines.
5. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed pictorial (3-D) drawing is correctly developed.

PROCESS

All performance elements are critical for correctly preparing a pictorial (3-D) drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill.

REFERENCE INFORMATION FROM AVAILABLE SOURCES.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drafting kit (Attachment A)
Drafting reference text
Manufacturers' catalogs

WORK TO BE PERFORMED

Reference and record information from available sources.

PERFORMANCE CRITERIA

All referenced information is recorded in notes.

The skill is completed within a one-hour time period.

PERFORMANCE ELEMENTS

1. Locate information from appropriate reference materials. (See the following examples.)
   a. Find tap drill size for a ½" nominal diameter American National Unified NF screw thread; record information.
   b. Find width across flats for 7/8" diameter American National Standard hexagon cap screw; record information.
   c. Find outside eye diameter of 5/16" nominal size American National Standard Cotter Pin; record information.
   d. Find ANS abbreviations for: diameter, fillet, required, nominal, schedule, and section; record information.
2. Select catalog product and record its specifications. (For example, select window from window manufacturer's catalog and record its specifications; select similar sized window from different manufacturer's catalog and record its specs.) Note all differences (e.g., rough opening size, part number, etc.).

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The information from available sources is correctly referenced and recorded.

PROCESS

All performance elements are critical for correctly referencing and recording information from available sources.

DIMENSION DRAWINGS.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Two copies of a drawing (Sample drawing in Attachment D)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text

WORK TO BE PERFORMED

Construct and dimension drawings.

PERFORMANCE CRITERIA

All major features on the drawings are appropriately dimensioned, neat, and clear of smudges.

All lines are distinct, easily read and of the appropriate line weight and type.

The drawing is dimensioned within a two-hour time period. (Time is based on using drawing in Attachment D to complete the skill.)

PERFORMANCE ELEMENTS

1. Identify dimensioning styles and methods (e.g., coordinate, linear/datum).
2. Select 2-D views to be dimensioned.
3. Dimension views on first drawing copy using coordinate dimensioning.
4. Dimension from one feature across to next, feature in order, until all dimensions have been located, drawn, and lettered. Dimension horizontally and vertically as needed until all features are dimensioned.
5. Dimension views on second drawing copy using linear (datum) as style of dimensioning.
6. Start all dimensions from common datum corner, designated 0, 0, 0 and continue to edge(s) of each feature being dimensioned. Dimension in this manner both vertically and horizontally until all dimensions have been located, drawn, and lettered. Continue until all features have been dimensioned.
7. Dimension complex shapes when appropriate (e.g., spheres, cylinders, tapers, pyramids).
8. Apply appropriate line thickness and type to dimension, extension, and center lines.
9. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed drawings are dimensioned correctly, showing all necessary details and information.

PROCESS

All performance elements are critical for correctly dimensioning drawings. The steps of performance are numbered to show an appropriate sequence for completing the skill.

APPLY NOTES AND LEADERS.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drawing (Sample drawing in Attachment F)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text

WORK TO BE PERFORMED

Apply notes and leaders.

PERFORMANCE CRITERIA

The finished drawing is appropriately labeled, neat and clear of smudges.

All lines are distinct, easily read and of the appropriate line weight and type.

The skill is completed within a half-hour time period. (Time is based on using drawing in Attachment F to complete the skill.)

PERFORMANCE ELEMENTS

1. Apply appropriate notes and/or leaders to drawing.
2. Apply appropriate lettering, line thickness and type.
3. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed drawing illustrates correct application of notes and leaders.

PROCESS

All performance elements are critical for correctly applying notes and leaders on a drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill.

MAKE DRAWING REVISIONS.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drawing (Sample drawing in Attachment G)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text
Departmental policy and procedures

WORK TO BE PERFORMED

Make drawing revisions.

PERFORMANCE CRITERIA

All major features on the drawings are neat and clear of smudges.

All lines are distinct, easily read and of the appropriate line weight and type.

The skill is completed within a one-hour time period. (Time is based on using drawing in Attachment G to complete the skill.)

PERFORMANCE ELEMENTS

1. Review drawing revision (change) procedures.
2. Identify drawing to be modified.
3. Make modifications to drawing.
4. Construct a revision table on drawing and, after completing changes (revisions), record them properly on revision table.
5. Apply appropriate line thickness and type.
6. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

The completed drawing illustrates all revisions have been correctly made and properly recorded.

PROCESS

All performance elements are critical for correctly revising and recording changes on a drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill.

PREPARE ISOMETRIC DRAWING.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Orthographic drawing (Sample drawing in Attachment H)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Prepare an isometric drawing.

PERFORMANCE CRITERIA

The drawing has correct view orientation.

All lines are distinct, dark, easily read and of the appropriate line weight and style.

Finished drawing is neat and clear of smudges and completed within a one-hour time period. (Time is based on completing the skill using drawing in Attachment H.)

PERFORMANCE ELEMENTS

1. Lay out isometric corner with left and right side lines each 30 degrees up from the horizontal and a third line at a vertical, with all three lines joining in a common intersection.
2. Use isometric corner to construct a full-scale (1:1) basic isometric drawing, including hidden features.
3. Select letter style and size.
4. Add notes and labels.
5. Darken finish lines.
6. Check drawings.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Isometric drawing is correctly prepared.

PROCESS

All performance elements are critical for correctly preparing isometric drawings. The steps of performance are numbered to show an appropriate sequence for completing the skill.

DRAW SECTION VIEWS.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Orthographic drawing (Sample drawings in Attachments I and J)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Draw section views.

PERFORMANCE CRITERIA

The drawings illustrate sectioned views of an object with correct line representation and view orientation.

All lines are distinct, dark, easily read and of the appropriate line weight and style.

Finished drawings are neat and clear of smudges and completed within a one-hour time period. (Time is based on completing the skill using drawings in Attachments I and J.)

PERFORMANCE ELEMENTS

1. Identify different sectioning methods for drawings: full, half, aligned, broken-out, revolved, removed and offset.
2. Select appropriate methods for sectioning in a drawing including crosshatching, break lines and cutting-plane line application.
3. Draw section views which include a full section A-A, an aligned section B-B, and an offset section C-C.
4. Select letter style and size.
5. Add notes and labels.
6. Darken all finish lines.
7. Check drawings.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Drawings are correctly constructed with sectioned views.

PROCESS

All performance elements are critical for a correctly constructed drawing with sectioned views. The steps of performance are numbered to show an appropriate sequence for completing the skill.

CONSTRUCT AN AUXILIARY VIEW.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Orthographic drawing (Sample drawing in Attachment H)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Construct an auxiliary view.

PERFORMANCE CRITERIA

The drawing shows auxiliary surface in true shape and size.

All lines are distinct, dark, easily read and of the appropriate line weight and style.

Finished drawing is neat and clear of smudges and completed within a one-hour time period. (Time is based on completing the skill using drawing in Attachment H.)

PERFORMANCE ELEMENTS

1. Select letter style and size.
2. Construct and label an auxiliary view.
3. Darken all finish lines.
4. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Auxiliary view is correctly constructed and labeled.

PROCESS

All performance elements are critical for a correctly constructed auxiliary view. The steps of performance are numbered to show an appropriate sequence for completing the skill.

IDENTIFY THREADS AND THREAD NOMENCLATURE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Thread drawing (Sample worksheet in Attachment K)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text

WORK TO BE PERFORMED

Identify threads and thread nomenclature.

PERFORMANCE CRITERIA

Thread nomenclature is identified within a twenty-minute time period. (Time is based on completing performance element one using worksheet in Attachment K.) Complete all performance elements within a one-hour time period.

PERFORMANCE ELEMENTS

1. Identify thread nomenclature and classification.
   a. Pitch
   b. Root
   c. External/internal threads
   d. Major/minor diameter
   e. Pitch diameter
   f. Crest
   g. Included (thread) angle
   h. Thread depth
   i. Thread series
   j. Thread class
   k. Right/left hand thread
2. Identify thread forms using research manuals. (Definitions are recommended for assessment process.)
   a. Sharp V
   b. Whitworth Standard
   c. Unified National
   d. Square
   e. Acme
   f. American National
   g. Metric
   h. Buttress
   i. Knuckle

3. Identify the three types of thread representation. (Definitions are recommended for assessment process.)
   a. Detailed
   b. Schematic
   c. Simplified
4. Research and identify typical threading designation (e.g., for ½ - 13 threads per inch, etc.).

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Threads and thread nomenclature are correctly identified.

PROCESS

All performance elements are critical for identifying threads and thread nomenclature.

DRAW AND LABEL FASTENERS.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Draw and label fasteners using correct nomenclature.

PERFORMANCE CRITERIA

The drawing illustrates views of fasteners with correct line representation.

Finished drawing is neat and clear of smudges and completed within a one-hour time period.

PERFORMANCE ELEMENTS

1. Identify fastener nomenclature and classification for the following items. (Identification drawings are recommended for assessment process.)
   a. Bolt
   b. Nut
   c. Cap screw
   d. Machine screw
   e. Set screw
   f. Woodruff key
   g. Machine pin
   h. Stud
   i. Lock nut
   j. Rivet
2. Draw and label the following fasteners using a template or appropriate CAD symbols library (scale 1:1):
   a. ¾"-10" UNC-2A x 3" hexagon head bolt
   b. 5/8" -12" Acme-2B square nut
   c. ½"-16" UNC-2A x 2-1/4" hexagon head cap screw
   d. No. 10 (.1900)–28 NF-3" x 5/8" slotted pan head machine screw
   e. No. 204 Woodruff key
3. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Fastener drawings are correctly drawn and labeled.

PROCESS

All performance elements are critical for correctly drawing and labeling fastener drawings.

CONSTRUCT AN ASSEMBLY DRAWING.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Working drawing (Sample drawing in Attachment L)
Drafting kit (Attachment A) or CAD workstation
Drawing paper with title block and border
Drafting reference text

WORK TO BE PERFORMED

Construct an assembly drawing.

PERFORMANCE CRITERIA

The assembly drawing presents a series of related parts assembled together correctly to form a single unit.

All lines are distinct, dark, easily read and of the appropriate line weight and style.

Finished drawing is neat and clear of smudges and completed within a three-hour time period. (Time is based on completing the skill using drawing in Attachment L.)

PERFORMANCE ELEMENTS

1. Draw front and top orthographic views for assembled object.
2. Select letter size and style.
3. Identify each separate part by providing a parts list and appropriate balloon call-outs.
4. Darken all finish lines.
5. Check drawing(s).

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Correctly constructed assembly drawing shows all necessary details and information.

PROCESS

All performance elements are critical for producing a correctly constructed assembly drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill; however, a different sequence may be used.

IDENTIFY GEARS AND GEARING NOMENCLATURE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Gearing drawing (Sample worksheet in Attachment M)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text

WORK TO BE PERFORMED

Identify gears and gearing nomenclature.

PERFORMANCE CRITERIA

Correct identification gear nomenclature is completed in thirty minutes. (Time is based on completing the skill using worksheet in Attachment M.)

PERFORMANCE ELEMENTS

1. Identify gears.
   a. Spur
   b. Worm
   c. Bevel
2. Identify gearing nomenclature.
   a. Working depth circle
   b. Base circle
   c. Addendum
   d. Pressure angle
   e. Pitch circle
   f. Addendum circle
   g. Dedendum
   h. Whole depth
   i. Working depth
   j. Clearance
   k. Fillet
   l. Top land
   m. Bottom land
   n. Radial line

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Gears and gear nomenclature are correctly identified.

PROCESS

All performance elements are critical for correctly identifying gears and gear nomenclature. The steps of performance are numbered to show an appropriate sequence for completing the skill; however, a different sequence may be used.

IDENTIFY CAMS, CAM NOMENCLATURE AND SKETCH A CAM PROFILE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Cam drawing (Sample worksheet in Attachment N)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text

WORK TO BE PERFORMED

Identify cams, cam nomenclature and sketch a cam profile.

PERFORMANCE CRITERIA

The sketch illustrates correct cam profile representation.

Cam profile sketch is neat and clear of smudges and completed within a 15-minute time period. (Time is based on completing worksheet in Attachment N.) Complete all performance elements within a 30-minute time period.

PERFORMANCE ELEMENTS

1. Identify cams. (Identification sketch is recommended for assessment process.)
   a. Cylindrical
   b. Flat
   c. Circular
2. Identify cam terminology. (Definitions are recommended for assessment process.)
   a. Follower
   b. Profile
   c. Displacement
   d. Roller
3. Complete cam profile sketch.
4. Check sketch.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Cam profile sketch is correctly constructed and nomenclature is correctly identified.

PROCESS

All performance elements are critical for completing the skill.

IDENTIFY WELDING JOINTS, NOMENCLATURE AND SYMBOLOGY.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Welding drawing (Sample worksheet in Attachment O)
Drafting kit (Attachment A) or CAD workstation
Drafting reference text

WORK TO BE PERFORMED

Identify welding joints, nomenclature and symbology.

PERFORMANCE CRITERIA

The skill is completed within a 30-minute time period. (Time is based on completing worksheet in attachment O.)

PERFORMANCE ELEMENTS

1. Identify welding joints. (Identification drawings are recommended for assessment process.)
   a. Butt
   b. Corner
   c. Lap
   d. Edge
   e. Tee
2. Identify welding terminology. (Identification drawings are recommended for assessment process.)
   a. Fillet
   b. Bevel
   c. Square groove
   d. V groove
   e. J groove
   f. U groove
   g. Slot
   h. Plug

3. Identify welding symbology.
   a. Size of weld
   b. Weld process or spec
   c. Type of weld
   d. Location of weld
   e. Length of weld
   f. Pitch of weld
   g. Weld all around
   h. Field weld symbol
4. Check work.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Welding joints, nomenclature and symbology are correctly identified.

PROCESS

All performance elements are critical for correctly identifying welding joints, nomenclature and symbology.

IDENTIFY TOLERANCING SYMBOLS AND FEATURE CONTROL INFORMATION.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Tolerancing symbols (Sample worksheets in Attachments P and Q)
Drafting kit (Attachment A)
Drafting reference text
ANSI Y14.5M-1982 (R_) specifications

WORK TO BE PERFORMED

Identify tolerancing symbols and feature control information.

PERFORMANCE CRITERIA

Tolerancing symbols and feature control information are correctly identified and completed within a 30-minute time period. (Time is based on completing the skill using worksheets in Attachments P and Q.)

PERFORMANCE ELEMENTS

1. Research and identify tolerancing nomenclature.
   a. Geometric characteristic symbol
   b. Diameter symbol (when used) zone descriptor
   c. Geometric tolerance
   d. Material condition symbol
   e. Primary datum reference
   f. Secondary datum reference
   g. Tertiary datum reference
2. Identify tolerancing symbols and feature control information.
   a. Position
   b. Flatness
   c. Circularity
   d. Angularity
   e. Perpendicularity
   f. Concentricity
   g. Profile surface
   h. Straightness
   i. Parallelism
   j. Runout circular
   k. Runout total
   l. Profile line

m. Symmetry
n. Free state
o. Maximum material conditions (MMC)
p. Least material conditions (LMC)
q. Tangent plane
r. Project tolerance
s. Cylindricity
t. Diameter
u. All around
v. Between
w. Straightness
x. Parallelism
y. Runout

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Tolerancing symbols and feature control information are correctly identified.

PROCESS

All performance elements are critical for correctly identifying tolerancing symbols and feature control information.

IDENTIFY SURFACE FINISH SYMBOLOGY.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Finish symbology drawing (Sample worksheet in Attachment R)
Drafting kit (Attachment A)
Drafting reference text

WORK TO BE PERFORMED

Identify surface finish symbology.

PERFORMANCE CRITERIA

Surface finish representation is correctly identified and completed within a 15-minute time period. (Time is based on completing worksheet in Attachment R.)

PERFORMANCE ELEMENTS

1. Identify surface finish nomenclature.
   a. Roughness width
   b. Roughness height
   c. Lay
   d. Roughness width cutoff
   e. Waviness height
   f. Waviness width
   g. Machining required
2. Identify components of a surface finish callout.
3. Check work.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

Surface finish symbology is correctly identified.

PROCESS

All performance elements are critical for correctly identifying surface finish symbology.

CREATE A CAD MODEL AND DRAWING.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Drawing (Sample drawing in Attachment D)
CAD workstation
Part specifications
Technical sketches
Drafting reference text

WORK TO BE PERFORMED

Create a model and drawing using a CAD program.

PERFORMANCE CRITERIA

Skill is performed using a modeling and drafting computer program.

Finished model and drawing is complete and accurate.

Skill is completed in three hours. (Time is based on completing the skill using drawing in Attachment D.)

PERFORMANCE ELEMENTS

1. Create wireframe, surface, or solid model.
   a. Create wireframe model
      1. Construct appropriate construction geometry (e.g., planes, coordinate systems, points).
      2. Construct geometric figures (e.g., lines, spline, circle, arcs).
      3. Create three-dimensional wireframe from two-dimensional geometry by projecting or extruding entities and connecting as required.
      4. Utilize geometry editing commands as required (e.g., trimming, extending).
   b. Create surface model
      1. Construct appropriate construction geometry (e.g., planes, coordinate systems, points).
      2. Create wireframe entities as required to define surfaces (see 1.a.).
      3. Create surfaces required to define boundaries of part.
      4. Use surface editing commands as required (e.g., extend, offset, copy, trim, fillet).
      5. Join surfaces to form volume or solid.

c. Create solid model
   1. Construct appropriate construction geometry (e.g., planes, coordinate systems, points).
   2. Create base geometry using primitives (e.g., cube, cylinder, sphere, cone) or by manipulating shape (e.g., extrude, revolve, sweep, blend).
   3. Add geometry to complete model by using primitive operations (e.g., merge, join, subtract, cut out) or by using feature-based geometry (e.g., holes, slots, rounds, chamfers).

d. Create cut sections through three-dimensional model.

2. Manipulate model.
   a. Control entity properties (e.g., color, line type).
   b. Use viewing commands (e.g., dynamic rotation, zooming, panning).
   c. Use display commands (e.g., hidden line removal, shading).
   d. Use layering techniques.
   e. Use grouping techniques.
   f. Shade/render object (e.g., reflectivity, opacity).
3. Perform drawing set-up (e.g., set drawing size, retrieve format).
4. Create appropriate two-dimensional drawing views from three-dimensional models.
5. Create cross-sectional view from three-dimensional model.
6. Dimension drawing using associative dimensioning.
7. Create lines and symbols to annotate drawing views (e.g., centerlines, cutting plane lines, balloons).
8. Create notes using appropriate text style and size to annotate drawing and title block.
9. Check drawing.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

CAD model and drawing are properly developed using modeling and drafting software program.

PROCESS

All performance elements are critical for correctly creating a CAD model and drawing. The steps of performance are numbered to show an appropriate sequence for completing the skill; however, a different sequence may be used.

ANALYZE CAD MODEL.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

CAD workstation
CAD solid model
Drafting reference text
Paper & pencil

WORK TO BE PERFORMED

Analyze and record CAD model data.

PERFORMANCE CRITERIA

Appropriate CAD model data is obtained and recorded with 100% accuracy within a one-hour time period.

PERFORMANCE ELEMENTS

1. Use query commands to interrogate database (e.g., entity characteristics, distance, area, status).
2. Obtain surface properties (e.g., area, perimeter, bounded volume).
3. Obtain mass properties data (e.g., moments of inertia, centroids).
4. Record/print CAD model data.

PERFORMANCE ASSESSMENT CRITERIA

PRODUCT

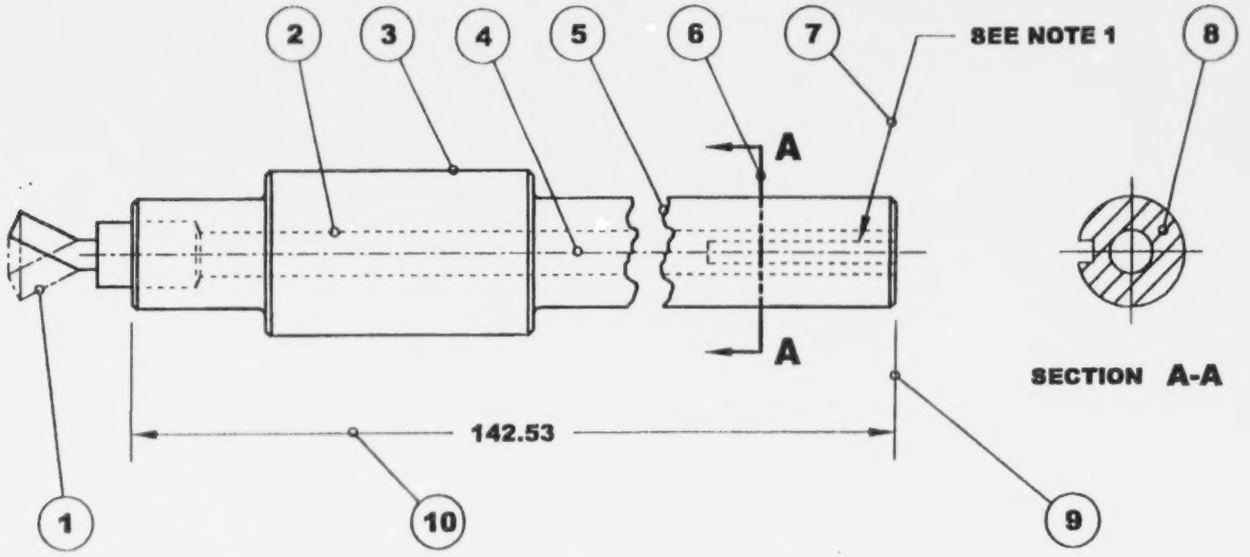
Appropriate CAD model data is analyzed and recorded.

PROCESS

All performance elements are critical for analyzing and recording CAD model data. The steps of performance are numbered to show an appropriate sequence for completing the skill; however, a different sequence may be used.

DRAFTING KIT	Lead holder/pencil
	Protractor
	Lead Pointer
	Eraser
	Erasing shield
	30-60-90 Triangle
	45-45-90 Triangle
	Drafting tape
	T-square/parallel bar
	Architect's scale
	Engineer's scale
	Metric scale
	Civil scale
	Instrument set (compass, dividers, etc)
	Lettering guide
	Templates (circle, arrowhead, etc.)
	Drafting tape
	Dusting brush
	Dusting powder

DRAFTING LINE TYPES (ALPHABET OF LINES)



ITEM	TYPE	ITEM	TYPE
1	PHANTOM LINE	6	CUTTING PLANE LINE
2	HIDDEN LINE	7	LEADER LINE
3	VISIBLE OBJECT LINE	8	SECTION LINE
4	CENTER LINE	9	EXTENSION LINE
5	BREAK LINE	10	DIMENSION LINE

ATTACHMENT C

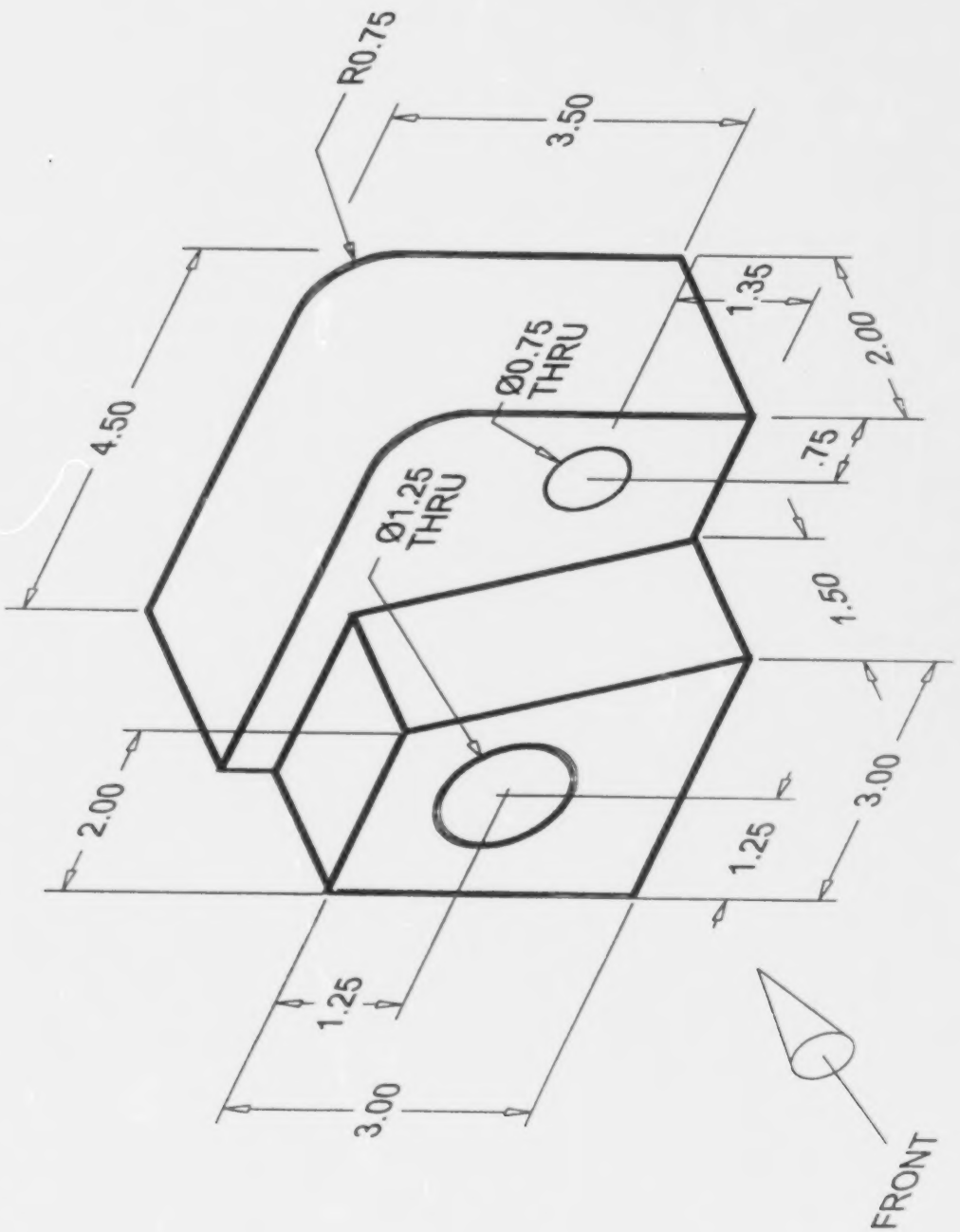
SAMPLE TEXT

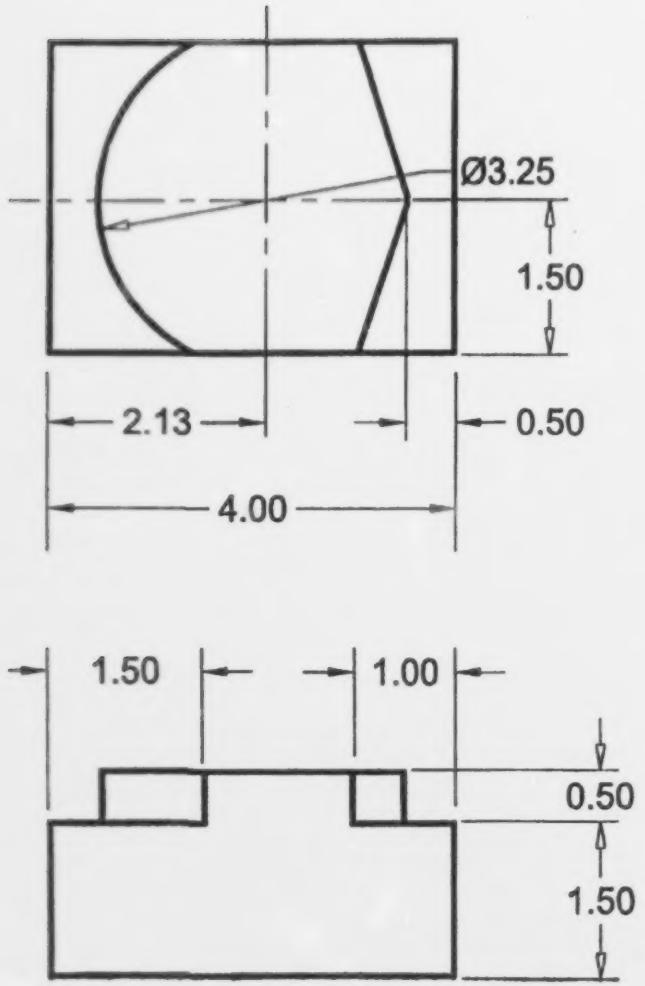
TECHNICAL DESIGN AND DRAWING (DRAFTING) UTILIZE A GRAPHIC LANGUAGE TO COMMUNICATE IDEAS AND CONCEPTS. THIS GRAPHIC LANGUAGE HAS BEEN DEVELOPED OVER THE CENTURIES BY ARCHITECTS, ENGINEERS, DESIGNERS, AND DRAFTERS UNTIL IT COMES TO TODAY'S DRAFTERS IIN ITS PRESENT FORM.

SO, WHAT IS DRAFTING? IT IS THE COMMON LANGUAGE OF INDUSTRY. DRAFTERS PRODUCE GRAPHICAL REPRESENTATIONS OF IDEAS OR PRODUCTS TO BE PROCESSED, MANUFACTURED, OR CONSTRUCTED. ENGINEERS, DESIGNERS, AND DRAFTERS UTILIZE THE DRAWING AND DESIGN PROCESS TO DEFINE, ESTABLISH, CREATE AND TRANSFER TECHNICAL INFORMATION. VIRTUALLY EVERYTHING THAT HAS BEEN CONSTRUCTED OR PRODUCED FIRST STARTED AS AN IDEA THAT WAS TRANSFERED ONTO A MDRAWING USING THE GRAPHICAL LANGUAGE OF INDUSTRY.

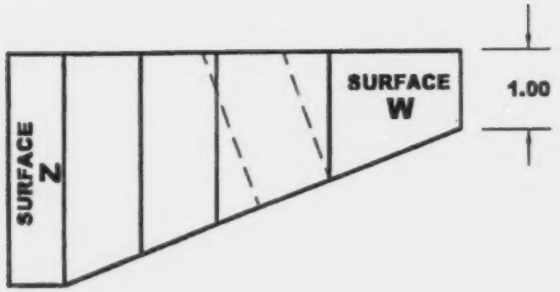
NOW, CONTINUE TO PRACTICE LETTERING BOTH LETTERS AND NUMBERS BY FOLLOWING THE EXAMPLES BELOW.

AAAA


R0.75
3.50
1.35
2.00
Ø0.75
THRU
4.50
.75
Ø1.25
THRU
1.50
2.00
3.00
1.25
1.25
3.00
FRONT

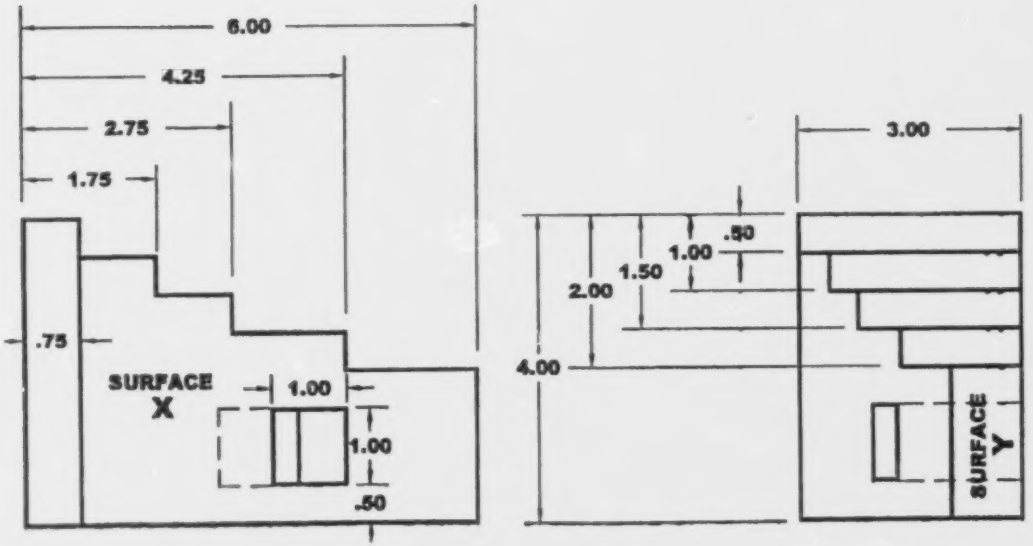


38-5

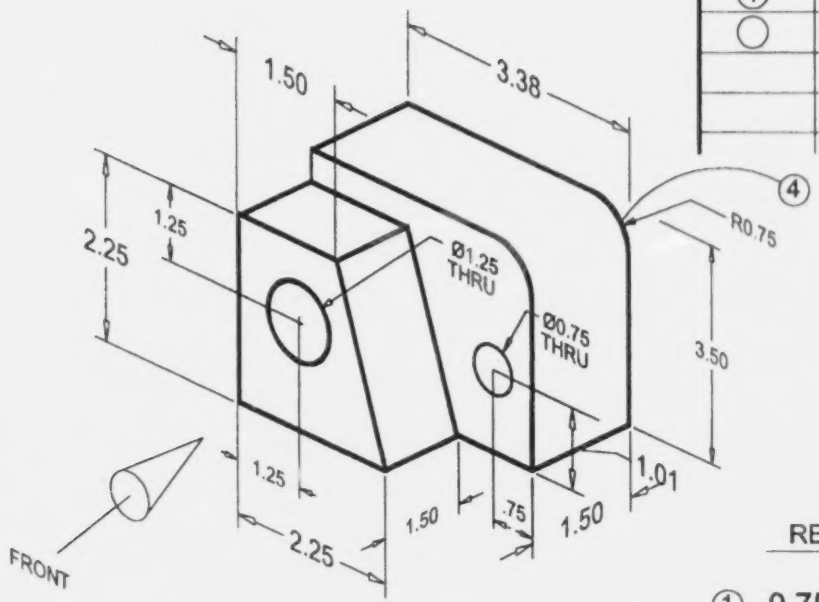


NOTE EACH OF THE FOLLOWING:

- SURFACE W TO BE MACHINE FINISH.
- SURFACE X TO BE GROUND AND POLISHED.
- SURFACE Y TO BE STAMPED WITH PART NUMBER IN CHARACTERS 4MM HIGH.
- SURFACE Z TO BE KNURLED FINISH.
- FILLETS & ROUNDS 1/8 R UNLESS OTHERWISE SPECIFIED.
- PART IS SAE 1020 - 1 REQUIRED.



REVISION TABLE			
SYMBOL	DESCRIPTION	DATE	APPROVAL
①			
○			



REVISIONS TO BE MADE

① 0.75 DIA TO 0.875 DIA

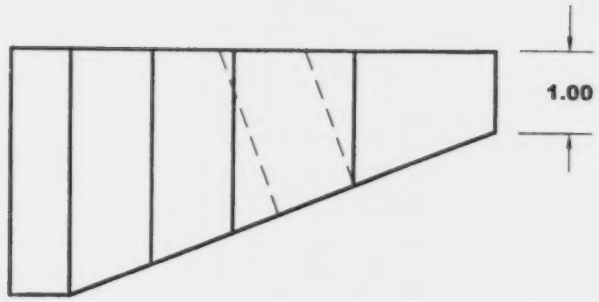
② 1.25 DIA TO 1.50 DIA

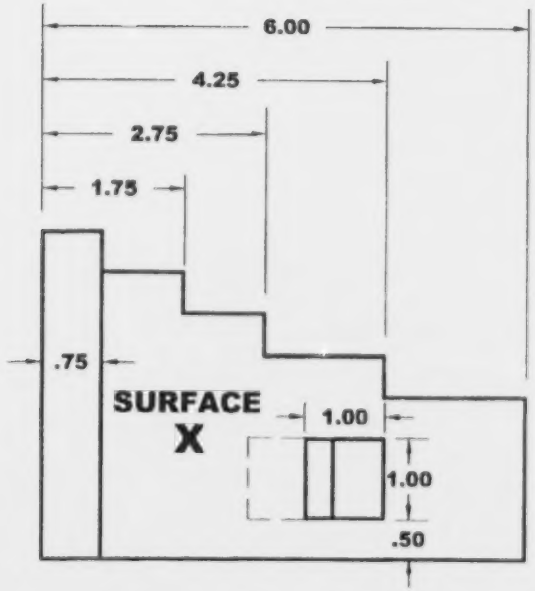
③ 1.01 TO 1.25

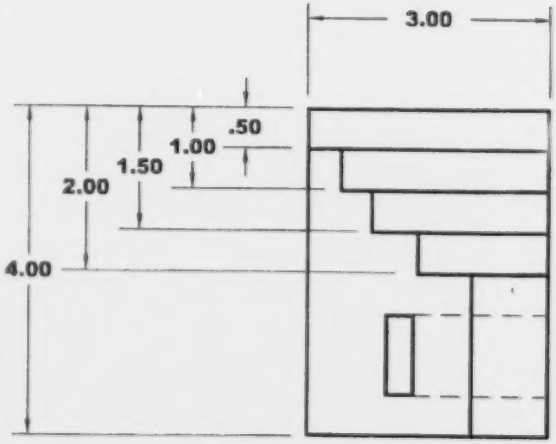
④ 0.75 R TO 0.875 R

⑤ 0.75 TO 0.80

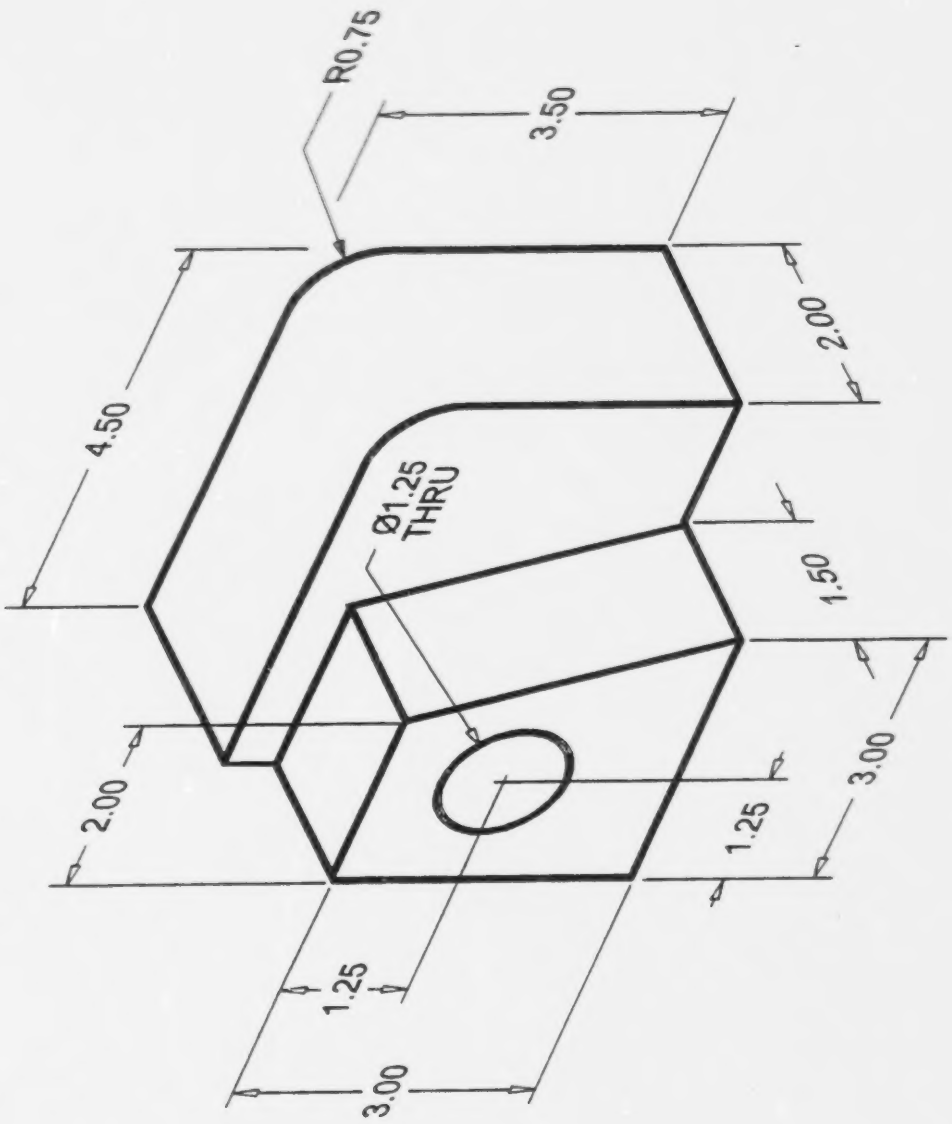
⑥ 1.50 DIA HOLE X 2.00 DEEP







MATERIAL: STEEL


R0.75
3.50
4.50
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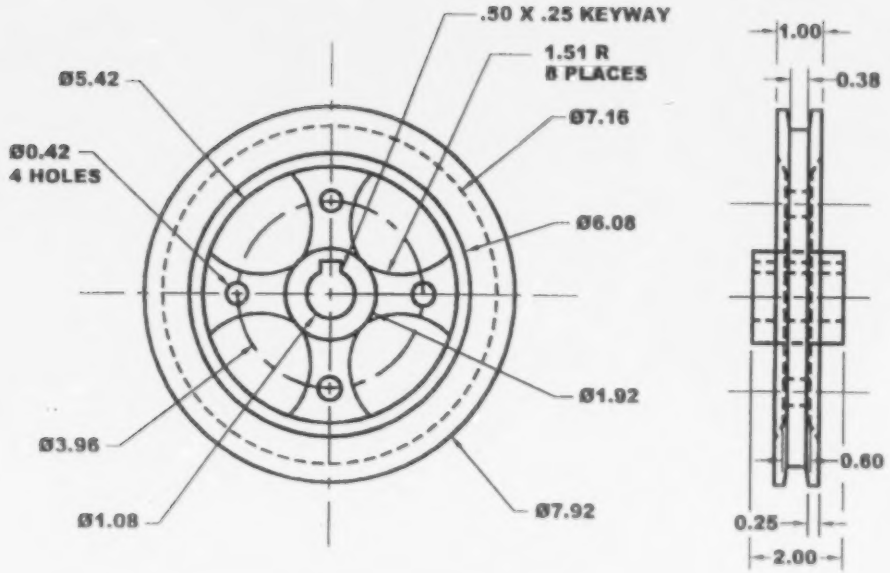
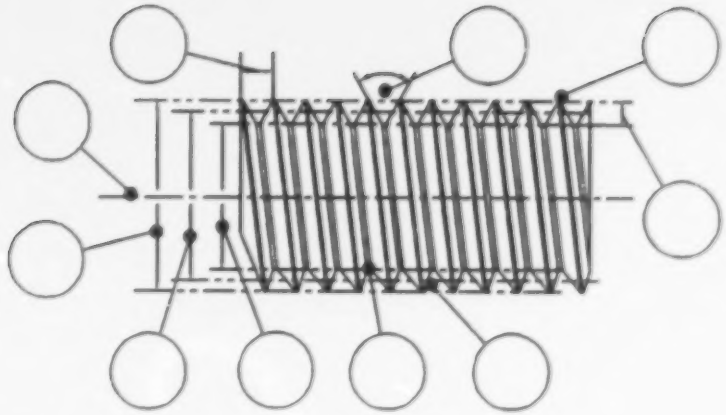
1.25
3.00

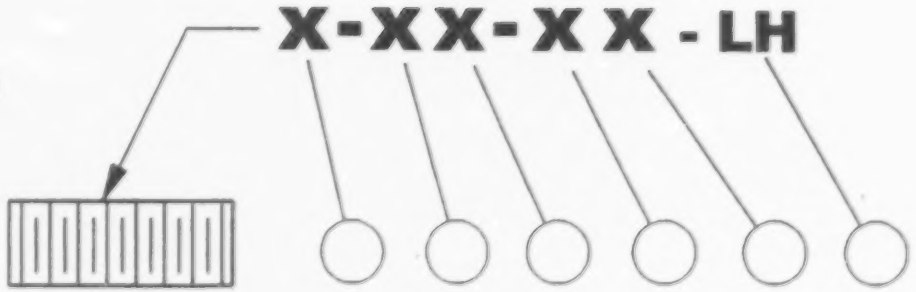


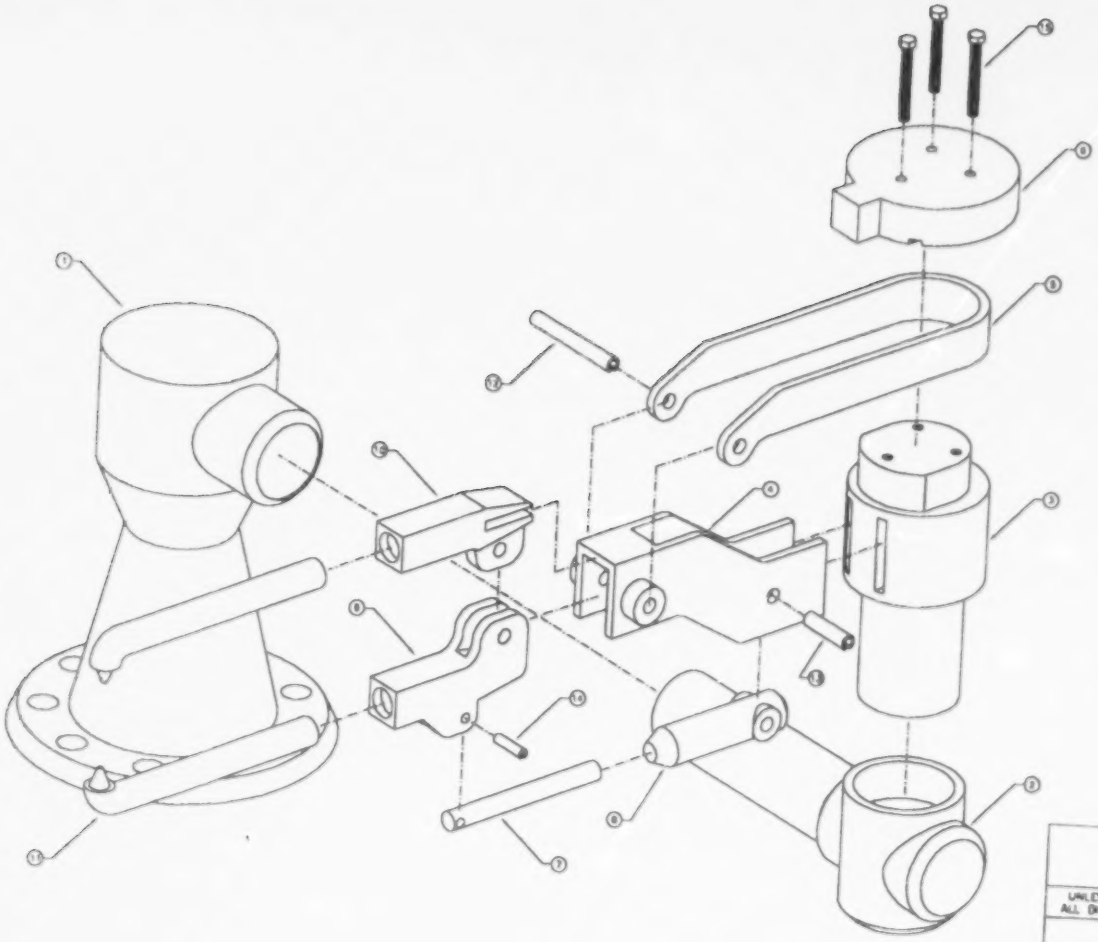
MATERIAL: CAST IRON

1 CREST
2 MINOR DIAMETER
3 ROOT
4 MAJOR (NOMINAL) DIAMETER
5 PITCH
6 PITCH DIAMETER
7 INCLUDED ANGLE
8 THREAD DEPTH
9 THREAD AXIS
10 THREAD SIDE

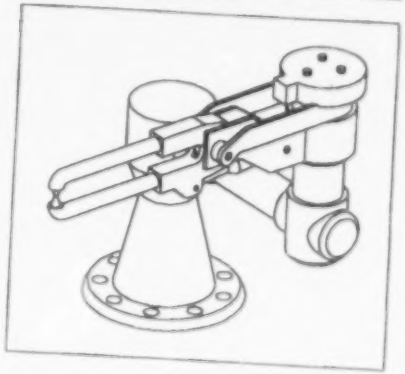


1 THREAD FORM
2 __?__ HAND THREAD
3 THREADS PER INCH
4 MAJOR (NOMINAL) DIAMETER
5 CLASS OF FIT
6 INTERNAL OR EXTERNAL THREAD





NO	PART NAME	REQD	MATL
1	BASE	1	STEEL
2	ARM	1	STEEL
3	MIDPIECE	1	STEEL
4	HOLDER	1	STEEL
5	SUPPORT	1	STEEL
6	FIXTURE	1	STEEL
7	RAM	1	STEEL
8	PLUNGER	1	STEEL
9	LOWER GRIP	1	STEEL
10	UPPER GRIP	1	STEEL
11	THONG	1	STEEL
12	3/16 X 1-1/2 SLOTTED SPRING PIN	2	BRASS
13	3/16 X 3/4 SLOTTED SPRING PIN	1	"
14	1/8 X 1/2 SLOTTED SPRING PIN	1	"
15	#1/8 X 1-1/4 MACHINE SCREW	3	"

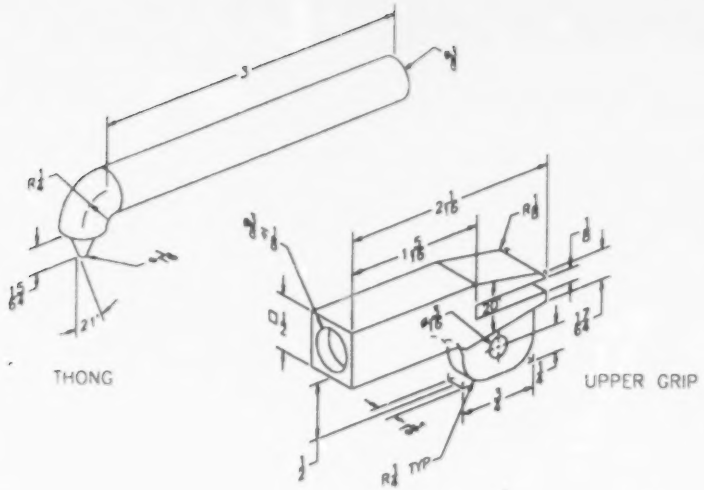


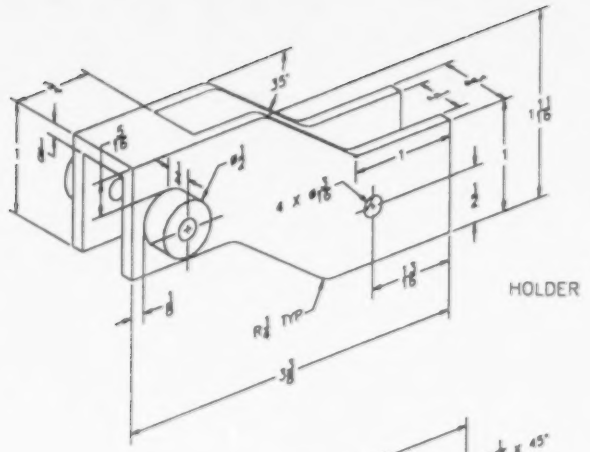
		TITLE: WELDER ARM
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES		DWG NO: ASSEMBLY
	TOLERANCES X ± .030 XX ± .002 XXX ± .001 ANGLES ± 1°	SCALE: NONE
		SHEET 1 OF 3

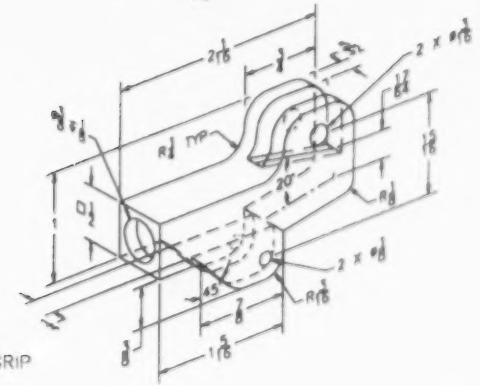
BEST COPY AVAILABLE

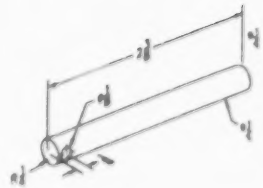
	TITLE: WELDER ARM
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES	DWG NO: COMPONENTS - A
TOLERANCES .X ± .030 .XX ± .005 .XXX ± .001 ANGLES ± 1°	SCALE: NONE
	SHEET 2 OF 3

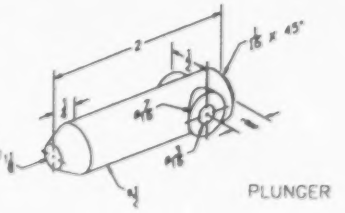
BEST COPY AVAILABLE



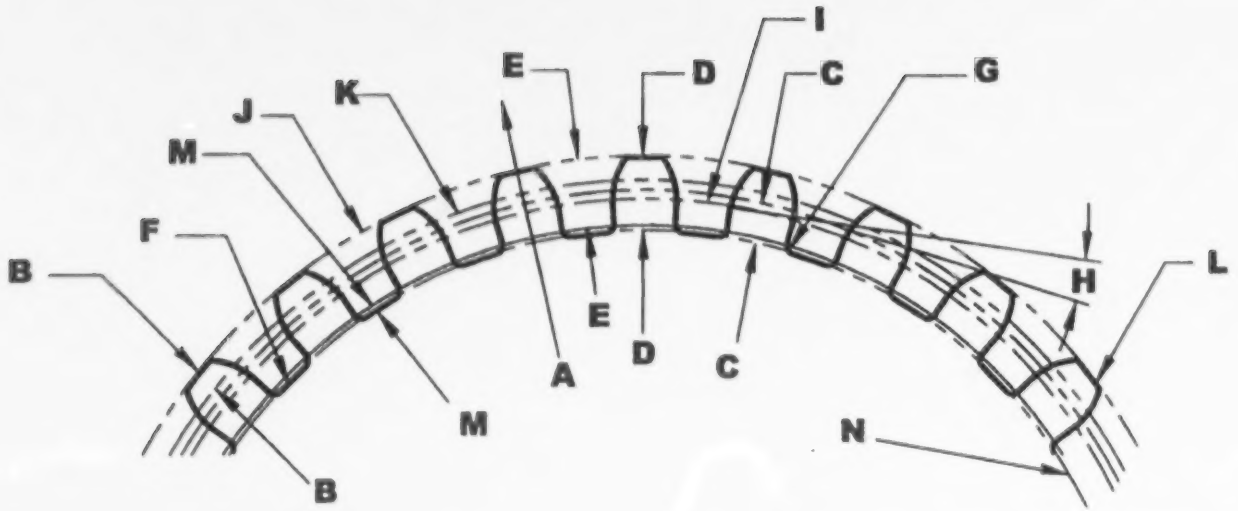








		TITLE: WELDER ARM
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES		DWG NO: COMPONENTS - B
	TOLERANCES .X ± .000 .XX ± .010 .XXX ± .001 ANGLES ± 1°	SCALE: NONE
		SHEET 3 OF 3

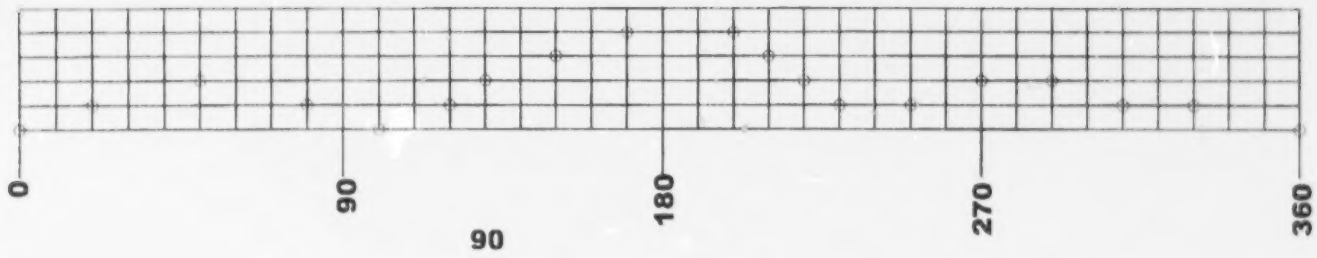


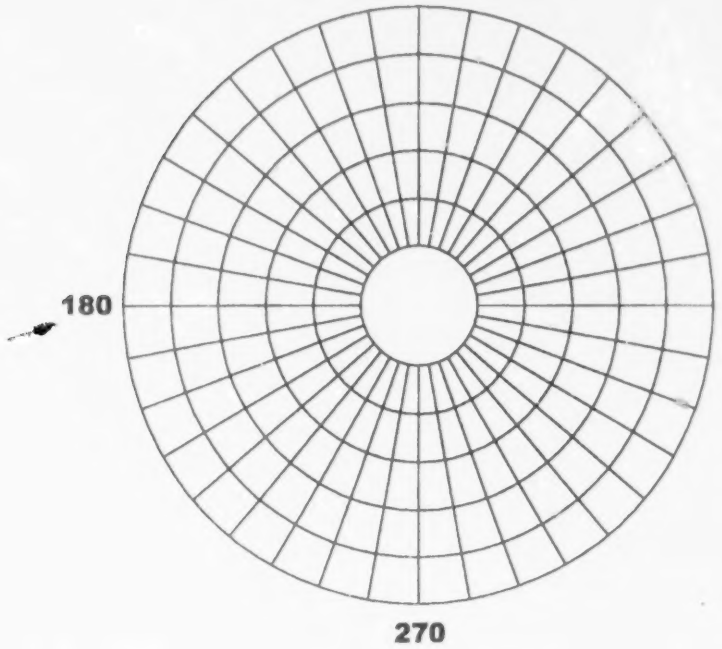
SPUR GEAR TERMINOLOGY

Working Depth Circle
Base Circle
Addendum
Pressure Angle
Pitch Circle
Addendum Circle
Dedendum
Whole Depth
Working Depth
Clearance
Fillet
Top Land
Bottom Land
Radial Line

76A

77





360, 0 ——— START HERE

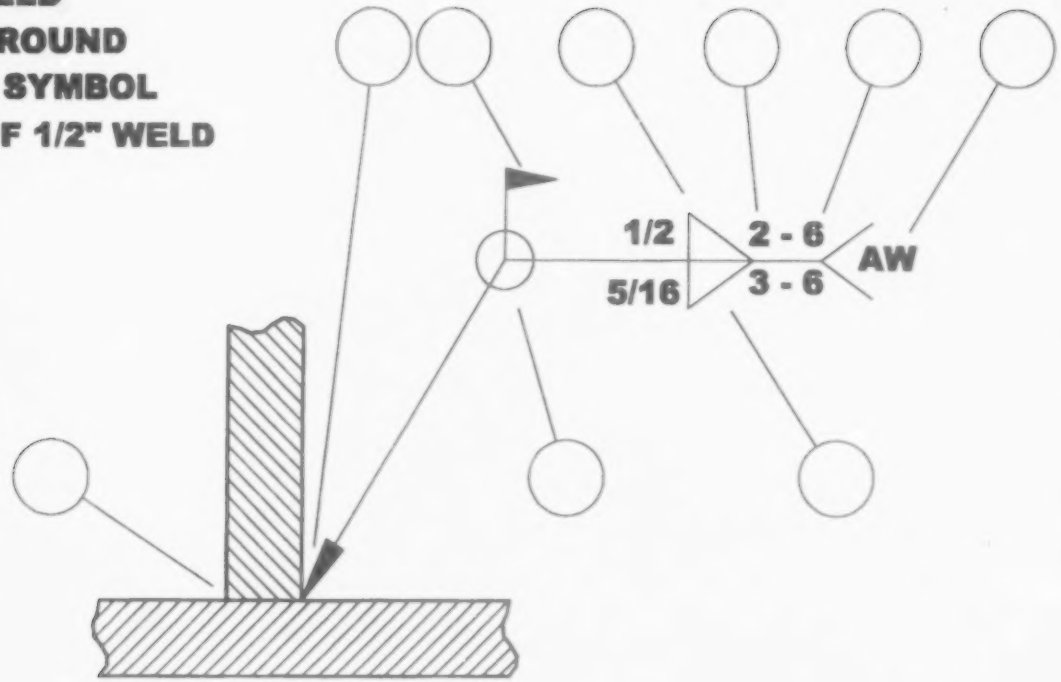
DIRECTIONS:

FROM THE POINTS SHOWN ON THE HORIZONTAL GRAPH, PLOT THE POINTS ON THE CIRCULAR CAM DIAGRAM IN ORDER TO DEFINE THE CAM CONTOUR.

77A

78

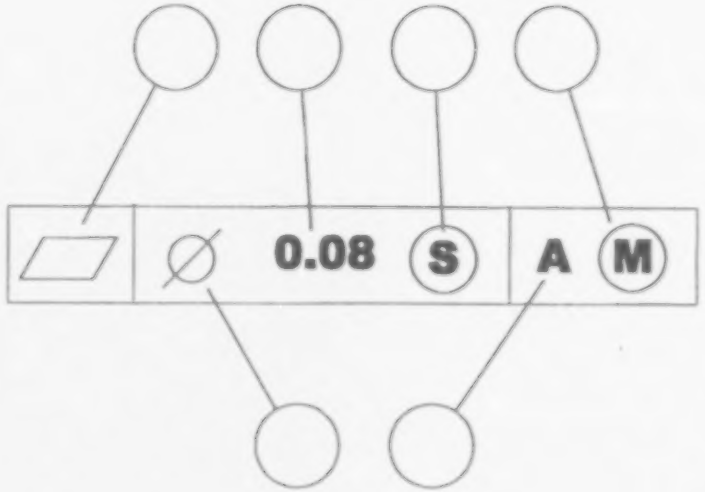
1 WELD PROCESS OR SPEC
2 TYPE OF WELD
3 LOCATION OF 5/16" WELD
4 LENGTH OF WELD
5 PITCH OF WELD
6 WELD ALL AROUND
7 FIELD WELD SYMBOL
8 LOCATION OF 1/2" WELD



SAMPLE DRAWING

38-17

1 DATUM REFERENCE
2 DIAMETER
3 GEOMETRIC CHARACTERISTIC SYMBOL
4 TOLERANCE
5 MODIFIER APPLICABLE TO TOLERANCE
6 MODIFIER OF DATUM



SAMPLE DRAWING

38-18

1 POSITION
2 FLATNESS
3 ROUNDNESS
4 ANGULARITY
5 PERPENDICULARITY
6 CONCENTRICY
7 STRAIGHTNESS
8 PARALLELISM
9 RUNOUT

ROUGHNESS WIDTH

ROUGHNESS HEIGHT

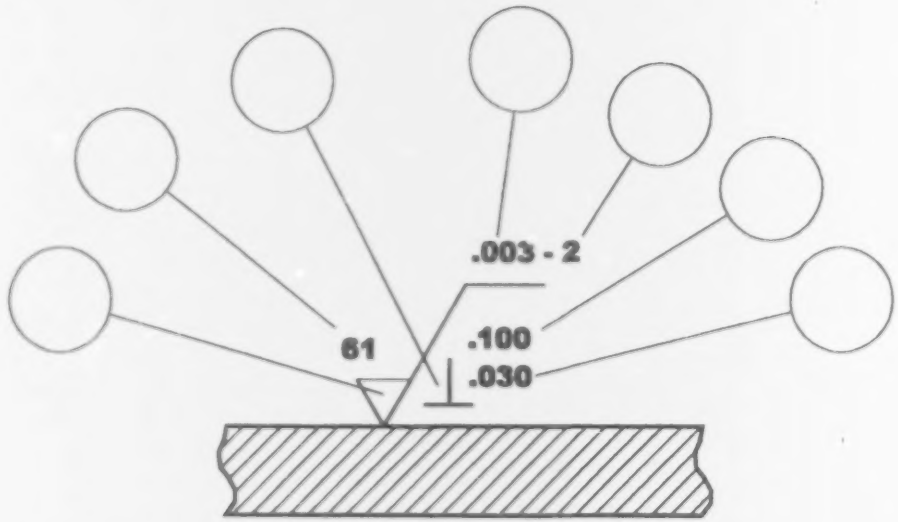
LAY

ROUGHNESS WIDTH CUTOFF

WAVINESS HEIGHT

WAVINESS WIDTH

MACHINING REQUIRED



ATTACHMENT R

SAMPLE DRAWING

38-20

APPENDIX A — GLOSSARY OF TERMS

Academic Skills	Skills (and related knowledge) contained in the subject areas and disciplines addressed in most national and state educational standards, including English, mathematics, science, etc.
Assessment	A process of measuring performance against a set of standards through examinations, practical tests, performance observations and/or the completion of work portfolios.
Content Standard	A specification of what someone should know or be able to do to successfully perform a work activity or demonstrate a skill.
Critical Work Functions	Distinct and economically meaningful sets of work activities critical to a work process or business unit which are performed to achieve a given work objective with work outputs that have definable performance criteria. A critical work function has three major components: • **Conditions of Performance:** The information, tools, equipment and other resources provided to a person for a work performance. • **Work to Be Performed:** A description of the work to be performed. • **Performance Criteria:** The criteria used to determine the required level of performance. These criteria could include product characteristics (e.g., accuracy levels, appearance), process or procedure requirements (e.g., safety, standard professional procedures) and time and resource requirements. The IOSSCC requires that these performance criteria be further specified by more detailed individual performance elements and assessment criteria.
Credentialing	The provision of a certificate or award to an individual indicating the attainment of a designated set of knowledge and skills and/or the demonstration of a set of critical work functions for an industry/occupational area.
Illinois Occupational Skill Standards and Credentialing Council (IOSSCC)	Legislated body representing business and industry which establishes skill standards criteria, endorses final products approved by the industry subcouncil and standards development committee and assists in marketing and dissemination of occupational skill standards.
Industry	Type of economic activity, or product or service produced or provided in a physical location (employer establishment). They are usually defined in terms of the Standard Industrial Classification (SIC) system.

Industry Subcouncil	Representatives from business/industry and education responsible for identifying and prioritizing occupations for which occupational performance skill standards are adapted, adopted or developed. They establish standards development committees and submit developed skill standards to the IOSSCC for endorsement. They design marketing plans and promote endorsed skill standards across the industry.
Knowledge	Understanding the facts, principles, processes, methods and techniques related to a particular subject area, occupation or industry.
Occupation	A group or cluster of jobs, sharing a common set of work functions and tasks, work products/services and/or worker characteristics. Occupations are generally defined in terms of a national classification system including the Standard Occupational Classification (SOC), Occupational Employment Statistics (OES) and the Dictionary of Occupational Titles (DOT).
Occupational Cluster	Grouping of occupations from one or more industries that share common skill requirements.
Occupational Skill Standards	Specifications of content and performance standards for critical work functions or activities and the underlying academic, workplace and occupational knowledge and skills needed for an occupation or an industry/occupational area.
Occupational Skills	Technical skills (and related knowledge) required to perform the work functions and activities within an occupation.
Performance Standard	A specification of the criteria used to judge the successful performance of a work activity or the demonstration of a skill.
Product Developer	Individual contracted to work with the standard development committee, state liaison, industry subcouncil and IOSSCC for the adaptation, adoption or development of skill standards content.
Reliability	The degree of precision or error in an assessment system so repeated measurements yield consistent results.
Skill	A combination of perceptual, motor, manual, intellectual and social abilities used to perform a work activity.
Skill Standard	Statement that specifies the knowledge and competencies required to perform successfully in the workplace.

Standards Development Committee	Incumbent workers, supervisors and human resource persons within the industry who perform the skills for which standards are being developed. Secondary and postsecondary educators are also represented on the committee. They identify and verify occupational skill standards and assessment mechanisms and recommend products to the industry subcouncil for approval.
State Liaison	Individual responsible for communicating information among all parties (e.g., IOSSCC, subcouncil, standard development committee, product developer, project director, etc.) in skill standard development.
Third-Party Assessment	An assessment system in which an industry-designated organization (other than the training provider) administers and controls the assessment process to ensure objectivity and consistency. The training provider could be directly involved in the assessment process under the direction and control of a third-party organization.
Validity	The degree of correspondence between performance in the assessment system and job performance.
Workplace Skills	The generic skills essential to seeking, obtaining, keeping and advancing in any job. These skills are related to the performance of critical work functions across a wide variety of industries and occupations including problem solving, leadership, teamwork, etc.

APPENDIX B

ILLINOIS OCCUPATIONAL SKILL STANDARDS AND CREDENTIALING COUNCIL

Margaret Blackshere	AFL-CIO
Judith Hale	Hale Associates
Michael O'Neill	Chicago Building Trades Council
Janet Payne	United Samaritans Medical Center
Gene Rupnik	Hospitality Industry
Jim Schultz	Illinois Retail Merchants Association Walgreen Company
Larry Vaughn	Illinois Chamber of Commerce

APPENDIX C

TRANSPORTATION, DISTRIBUTION AND LOGISTICS SUBCOUNCIL

Sam Anderson	Vice President American Postal Workers' Union
Alexi Carli	Subcouncil Chair Region Manager of Health/Safety United Parcel Service
Colleen Bueche	Human Resources Supervisor Enterprise Rent-A-Car
John Burner	Assistant State Director United Transportation Union
Elwood Flowers	Lobbyist Amalgamated Transit
Carl Gallman	Administrative Assistant International Association of Machinists
Karl Gnadt	Assistant to the Managing Director Champaign/Urbana Mass Transit District
Donald Good	Manager, Transportation Network U.S. Postal Service, Chicago Central P&DC
Wayne Grieder	President Archer Kostner Automotive
Thomas Nicely	Logistic Specialist JKC Trucking Company
David Regner	Illinois School Transportation Association
Roger Roberson	CEO PFT/Roberson Corporation
Dianna Rushing	Association of Flight Attendant's Council
Carolyn Schoeneman	Manager Ground Employment ORDEX- United
Joseph Szabo	State Director United Transportation Union
Paul Tatman	President Tatman Auto Body, Inc.

Russ Verona	President East Rockford Collision Center-North
Michael Wagner	General Manager Alpha Special Services
Vince Waters	Illinois Chapter of the American Concrete Pavement Association
Russ Wittkop	Special Representative, Midwest Territory International Association of Machinists
Gerald Zero	Secretary/Treasurer Illinois AFL-CIO Teamsters' Union
Ron Engstrom	State Liaison Illinois State Board of Education

APPENDIX D

MECHANICAL DRAFTING CLUSTER STANDARDS DEVELOPMENT COMMITTEE

Dale Bradley	ITW Impro
Randy Burton	Project Team Leader Butler Technical Group
Josh Daley	Henneman Raufeisen
Bob Devries	Drafting Instructor Pittsfield High School
Edward W. Faudel	Tooling Specialist Caterpillar
Neal Girard	CAD Project Manager Chemstress Consulting Company
Don Jenkins	State Farm Insurance
Paul Lennon	Educator Rushville High School
C. Praveen Reddy	Branch Manager Butler Technical Group
Dan Roush	Design Synergy Group
Dan Sergison	Project Team Leader Butler Technical Group
Pat Spicer, Ph.D.	Product Developer Western Illinois University
Ron Engstrom	State Liaison Illinois State Board of Education

I. Occupational Definition and Justification

A. Occupational Definition

The Transportation, Distribution and Logistics and Manufacturing Subcouncils identified drafting/CAD as a major cluster. Drafters translate the ideas and rough sketches of engineers, architects and scientists into detailed drawings which enable other workers to manufacture the product or construct the project. Their duties may include interpreting directions given to them, making sketches, preparing drawings to scale, and specifying details. They use various drafting tools, engineering practices and math to complete drawings.

Drafters increasingly use computer-aided design (CAD) systems. These systems make it easy to prepare many variations of a design and allow it to be viewed from angles not usually available with traditional drafting methods. Upper level career ladder positions requiring mechanical drafting skills, such as engineering, are currently using solid modeling and geometric tolerancing. The industry is currently in a transition period. However, in the near future a draftsperson will need to have solid modeling and geometric tolerancing skills.

The basic core skills are those skills that are applicable to all occupations in the drafting cluster occupational area.

B. Employment and Earnings Opportunities

1. Education and Training Requirements

The occupations in this occupational cluster do require "basic workplace skills and technical training."

2. Employment Opportunities

Employers include engineering and architectural firms, electronics firms, metals, machinery, construction companies and government agencies. Drafters/detailers may advance to positions requiring more skill and experience such as checkers, senior drafters, designers or supervisors.

Nationally, slower than average employment growth is expected for drafters through the year 2006. While in Illinois, a slight decline is expected in employment of drafters. Widespread use of computer-aided design techniques may reduce the need for drafters, yet increase the demand for skilled applicants. There are many people completing training programs that qualify them for work as drafters. Competitions for job openings will remain keen. Opportunities will be best for those trained in the use of computer-aided drafting systems and electronic drafting equipment.

3. **Earnings Opportunities**

	Middle Range Annual Earnings, 1998*
Draftsperson/detailer	$24,585 - $32,880
Checker	$30,800 - $39,000

** Middle range is the middle 50%, i.e., one-fourth of persons in the occupation earn below the bottom of the range and one-fourth of persons in the occupation earn above the top of the range.*

Sources: 1999 Occupational Employment Statistics: Wage Data and Occupational Projections 2006, Illinois Department of Employment Security, Economic Information and Analysis Division; Horizons Career Information System; and, *Encyclopedia of Careers & Vocational Guidance-10th Edition.*

II. Occupational Standards and Credentials

A. Occupational Standards

Performance Areas in the mechanical drafting standards cluster are divided into three segments: Basic Core Drafting Skills, Mechanical Drafting Skills and Mechanical Drafting CAD Skills.

B. Assessment and Credentialing System

III. Industry Support and Commitment

A. Industry Commitment of Development and Updating

1. The Transportation, Distribution and Logistics Subcouncil and the Standards Development Committee developed these performance skill standards. The development effort utilized the following steps:
   a. Identification of performance skills,
   b. Review of resources,
   c. Development of draft performance skills,
   d. Convening of Standards Development Committee,
   e. Validation and approval of performance skills by Standards Development Committee,
   f. Review of skill standards by Standards Development Committee,
   g. Review and approval of the skill standards by the Subcouncil,
   h. Endorsement of skill standards by the Council.
2. The Standards Development Committee members recommended that (when possible) individuals learn hand drafting skills before CAD skill manipulation.
3. A list of Subcouncil and Standards Development Committee members may be seen in Appendixes C and D, respectively.

B. **Industry Commitment for Marketing**

The Transportation, Distribution and Logistics Subcouncil is committed to marketing to and obtaining support and endorsement from the leading industry associations impacted by the skill standards. Upon recognition/endorsement of the skill standards by the Illinois Occupational Skill Standards and Credentialing Council (IOSSCC), the Subcouncil strongly recommends the development of an in-service/seminar package for use by members of the Transportation, Distribution and Logistics Subcouncil in providing awareness of the industry and obtaining full industry commitment to the development of a full industry marketing plan.

The Subcouncil encourages that the occupational skill standards be made available to the public, including students, parents, workers, educators at all levels, employers and industry organizers.

A. Developing an Employment Plan	1. Match interests to employment area. 2. Match aptitudes to employment area. 3. Identify short-term work goals. 4. Match attitudes to job area. 5. Match personality type to job area. 6. Match physical capabilities to job area. 7. Identify career information from counseling sources. 8. Demonstrate a drug-free status.
B. Seeking and Applying for Employment Opportunities	1. Locate employment opportunities. 2. Identify job requirements. 3. Locate resources for finding employment. 4. Prepare a resume. 5. Prepare for job interview. 6. Identify conditions for employment. 7. Evaluate job opportunities. 8. Identify steps in applying for a job. 9. Write job application letter. 10. Write interview follow-up letter. 11. Complete job application form. 12. Identify attire for job interview.
C. Accepting Employment	1. Apply for social security number. 2. Complete state and federal tax forms. 3. Accept or reject employment offer. 4. Complete employee's Withholding Allowance Certificate Form W-4.
D. Communicating on the Job	1. Communicate orally with others. 2. Use telephone etiquette. 3. Interpret the use of body language. 4. Prepare written communication. 5. Follow written directions. 6. Ask questions about tasks.
E. Interpreting the Economics of Work	1. Identify the role of business in the economic system. 2. Describe responsibilities of employee. 3. Describe responsibilities of employer or management. 4. Investigate opportunities and options for business ownership. 5. Assess entrepreneurship skills.
F. Maintaining Professionalism	1. Participate in employment orientation. 2. Assess business image, products and/or services. 3. Identify positive behavior. 4. Identify company dress and appearance standards. 5. Participate in meetings in a positive and constructive manner. 6. Identify work-related terminology. 7. Identify how to treat people with respect.

96 A

G. Adapting to and Coping with Change	1. Identify elements of job transition. 2. Formulate a transition plan. 3. Identify implementation procedures for a transition plan. 4. Evaluate the transition plan. 5. Exhibit ability to handle stress. 6. Recognize need to change or quit a job. 7. Write a letter of resignation.
H. Solving Problems and Critical Thinking	1. Identify the problem. 2. Clarify purposes and goals. 3. Identify solutions to a problem and their impact. 4. Employ reasoning skills. 5. Evaluate options. 6. Set priorities. 7. Select and implement a solution to a problem. 8. Evaluate results of implemented option. 9. Organize workloads. 10. Assess employer and employee responsibility in solving a problem.
I. Maintaining a Safe and Healthy Work Environment	1. Identify safety and health rules/procedures. 2. Demonstrate the knowledge of equipment in the workplace. 3. Identify conservation and environmental practices and policies. 4. Act during emergencies. 5. Maintain work area. 6. Identify hazardous substances in the workplace.
J. Demonstrating Work Ethics and Behavior	1. Identify established rules, regulations and policies. 2. Practice cost effectiveness. 3. Practice time management. 4. Assume responsibility for decisions and actions. 5. Exhibit pride. 6. Display initiative. 7. Display assertiveness. 8. Demonstrate a willingness to learn. 9. Identify the value of maintaining regular attendance. 10. Apply ethical reasoning.
K. Demonstrating Technological Literacy	1. Demonstrate basic keyboarding skills. 2. Demonstrate basic knowledge of computing. 3. Recognize impact of technological changes on tasks and people.
L. Maintaining Interpersonal Relationships	1. Value individual diversity. 2. Respond to praise or criticism. 3. Provide constructive praise or criticism. 4. Channel and control emotional reactions. 5. Resolve conflicts. 6. Display a positive attitude. 7. Identify and react to sexual intimidation/harassment.
M. Demonstrating Teamwork	1. Identify style of leadership used in teamwork. 2. Match team member skills and group activity. 3. Work with team members. 4. Complete a team task. 5. Evaluate outcomes.

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